USED LUBE OIL ANALYSIS

&

ANALYTICAL FERROGRAPHY

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Oil Analysis Provides Four Important Pieces of Information

1) Condition of Equipment Lubricated Components
(Bearings, gears, cylinders, & other lubricated components)

2) Condition of Lubricant -- Can we continue to use the lubricant with a high level of confidence?

3) Level of Contamination -- How contaminated is the lubricant? What is the contamination? Where did it come from? How can we prevent it from occurring again?

4) What do I do next?

Condition of Lubricated Components

Determined primarily by:

Spectroscopy for ionic and small metal particles

Direct Read Ferrography for mostly ferro-magnetic particles

-- or --

PQ Index for ferro-magnetic particles

ISO Particle Count for all particles according to size range.

Condition of Lubricated Equipment Components

Spectrographic Metals Analysis

1: Atomic Emission Rotrode Spectrometer

Particle size limitation ~ 7 µ, depending on metal and level of surface oxidation

Accurate to about ± 5%

No dilution of sample is required

Results include wear, additive, and contaminant metals in parts per million (ppm)

Condition of Lubricated Equipment Components

Spectrographic Analysis

2: Inductively Coupled Plasma Spectrometer

Particle size limitation ~ 7 µ, depending on metal

Accurate to about ± 1%

Dilution of sample is required

Results include wear, additive, and contaminant metals in parts per million (ppm)

Condition of Lubricated Equipment Components

Usually 18 to 22 wear, additive, and contaminant metals are detected

Wear	Additive	Contaminant
Iron	Zinc	Boron
Copper	Phosphorus	Silicon
Lead	Magnesium	Potassium
Tin	Calcium	Sodium
Chromium	Barium	Vanadium
Titanium	Molybdenum	
Nickel	Antimony	
Aluminum		
Silver		
Cadmium		

Condition of Lubricated Equipment Components

Metals by Atomic Emission Spectroscopy

Up Down Top Next 5 Previouse 5

Sample Information

Sample No	Hrs/Miles	Samp Date
5033004		2005-03-01
5023004		2005-02-01
5013004		2005-01-01
4123004		2004-12-01
4113004		2004-11-01
4103004		2004-10-01

Watch Advisory
Warning Advisory
Reference

Wear Metals

Iron	Coppe	Tin	Lead	Chrom	Nicke	Alumi	Titan	Silv
38	18	0	0	0	0	0	0	0
24	11	0	0	0	0	0	0	0
18	5	0	0	0	0	0	0	0
16	3	0	0	0	0	0	0	0
10	1	0	0	0	0	0	0	0
12	3	0	0	0	0	0	0	0
15	10	10	10	5	5	10	5	5
30	20	20	20	10	10	20	10	10
0	0	0	0	0	0	0	0	0

Basic bearing, gear, and shaft wear metals are monitored and trended

Ref: MRT Laboratories

Condition of Lubricated Equipment Components

Metals by Atomic Emission Spectroscopy

Additive Metals							Contaminant Metals				
Calci	Magne	Zinc	Phosp	Bariu	Molyb	Antim	Silic	Sodiu	Boron	Potas	Vanad
0	0	0	0	0	0	0	15	82	0	44	0
0	0	0	0	0	0	0	8	36	0	24	0
0	0	0	0	0	0	0	4	18	0	11	0
0	0	0	0	0	0	0	0	4	0	6	0
0	0	0	0	0	0	0	0	1	0	2	0
0	0	0	0	0	0	0	0	1	0	0	0
							10	40	10	15	10
							20	40	20	30	20
0	0	0	0	0	0	0	0	0	0	0	0

Additive metals are monitored.

Contaminant metals will help indicate source of contamination

Ref: MRT Laboratories

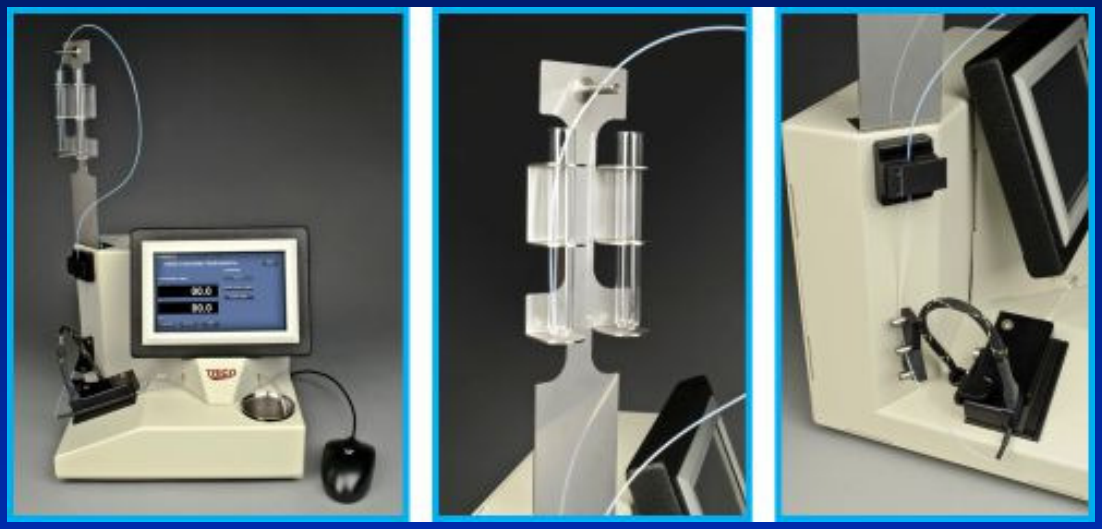
Condition of Lubricated Equipment Components

Direct Read Ferrography

- Reported as Direct Read Small (DRS) & Direct Read Large (DRL)
- Unit-less numbers range from 0.1 to 180.0
- Indicative of ferromagnetic particles & some non-magnetic particles
- Can “see” large particulates (> 300 microns)

Condition of Lubricated Equipment Components

Trico's DR7 Direct Read Ferrography Instrument



Sample flows through a glass tube sitting on an inclined magnet with two light paths – DRL and DRS.

The attenuation of light in each light path during the run produces a unitless result ranging from 0.00 to 180.00

Ferro-magnetic particles as well as heavier non magnetic particle contribute to the light attenuation.

Ref: TRICO Corp.

Condition of Lubricated Equipment Components

PQ Index

Analex's PQL Ferrous Debris Monitor

A magnetometer that measures the mass of ferro-magnetic debris in a sample and displays this as a PQ (Particle Quantifier) index.

The PQ Index is a quantitative unitless number ranging from 0 to 5000

Independent of particle size

Ref: Kittiwake

Condition of Lubricated Equipment Components

Particle Count Analysis

Determines Cleanliness of Lubricant and Other Fluids by measuring scattered laser light.

Reported at 4, 6, 14 micron thresholds (ISO 4406.1999)

ISO Code

Expressed as x/x/x

Ex: 16/14/11

16 -- >4 µ

14 -- > 6 µ

11 -- >14 µ

Number of Particles Per Milliliter

ISO 4406 Range Number	Greater Than	Less Than
24	80,000	160,000
23	40,000	80,000
22	20,000	40,000
21	10,000	20,000
20	5,000	10,000
19	2,500	5,000
18	1,300	2,500
17	640	1,300
16	320	640
15	160	320
14	80	160
13	40	80
12	20	40
11	10	20
10	5	10
9	2.5	5
8	1.3	2.5
7	0.64	1.3
6	0.32	0.64
5	0.16	0.32
4	0.08	0.16
3	0.04	0.08
2	0.02	0.04
1	0.01	0.02

Condition of Lubricated Equipment Components

Particle Count Analysis

Sample Information		Physical and Other Tests											
Sample No	Samp Date	V@40c	AN	Flash	ISO Code	KF	Color	4u	6u	14u	21u	38u	68u
5033005	2005-03-01	28.5	0.09	295	20/17/13	82	3.5	8716.5	1108.8	72.6	14.3	3.5	2.2
5023005	2005-02-01	29.1	0.07	350	17/14/12	42	2	1023.9	159	36.4	8.9	2.3	0.6
5013005	2005-01-01	31.9	0.06	370	16/14/12	48	2	544.4	110.7	30.6	6.6	1.9	0
4123005	2004-12-01	31.7	0.04	385	15/14/12	56	2	303.7	85.6	32.1	2.6	0.5	0
4113005	2004-11-01	32.2	0.04	385	16/13/12	66	2	488.5	74.3	36.8	3.6	0.4	0
4103005	2004-10-01	32.1	0.05	380	16/13/11	51	2	467.2	59.4	18.2	6.4	1.6	0
Watch Advisory		28.8-35.2	0.15	360	20/18/16	100	2						
Warning Advisory		27.2-38.8	0.2	340	21/19/17	200	4						
Reference		31.8	0.05	395	13/11/07	43	0	41.6	13.5	1.3	0.5	0	0

ISO 4406 Code plus actual Particles per CC of oil reported.

The Need for Microscopic Particle Examination

From Standard Lube Oil Analysis results:

We know there are metals present

Wear Metals

Iron	Coppe	Tin	Lead	Chrom	Nicke	Alumi	Titan	Silv
38	18	0	0	0	0	0	0	0
24	11	0	0	0	0	0	0	0
18	5	0	0	0	0	0	0	0
16	3	0	0	0	0	0	0	0
10	1	0	0	0	0	0	0	0
12	3	0	0	0	0	0	0	0

We know there are particles present

4u	6u	14u	21u	38u	68u
8716.5	1108.8	72.6	14.3	3.5	2.2
1023.9	159	36.4	8.9	2.3	0.6
544.4	110.7	30.6	6.6	1.9	0
303.7	85.6	32.1	2.6	0.5	0
488.5	74.3	36.8	3.6	0.4	0
467.2	59.4	18.2	6.4	1.6	0

..but were not sure what component they came from or what's causing them to be generated…

Microscopic Particle Analysis

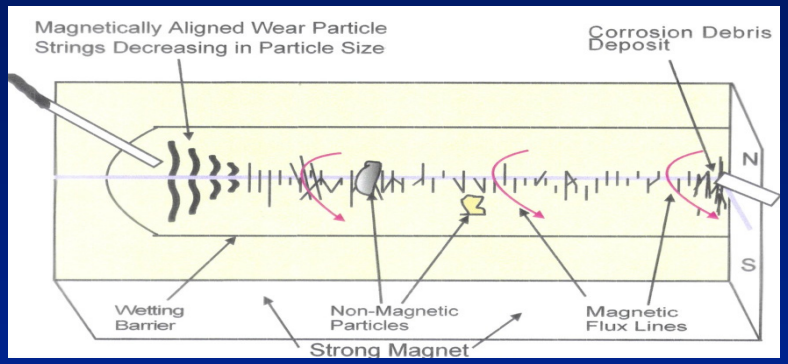
Microscopic Particle Analysis is usually performed as a reaction to routine test results.

Often performed for cause, such as increased bearing temperature, increase in filter DP, etc..

Best way to identify particulates reported by the ISO 4406 particle count, PQ Index, or Direct Read Ferrography

Best way to evaluate wear severity and wear mode

Microscopic Particle Analysis

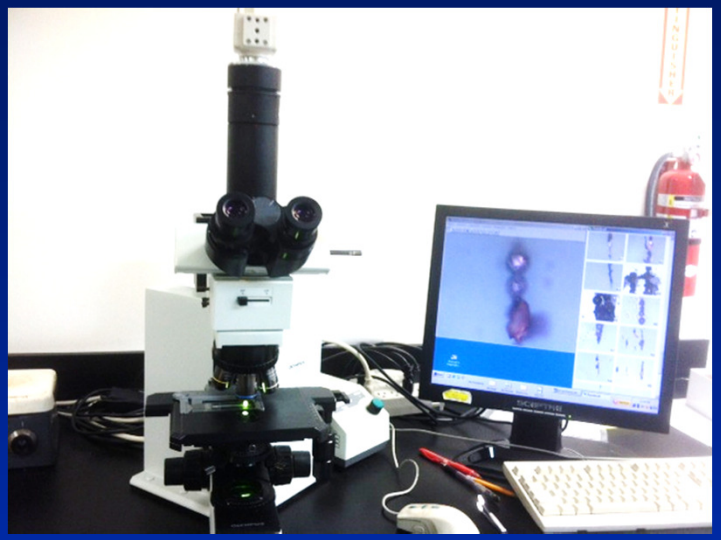


Ferrogram is made on Slide Maker

Slide is washed with heptane that has been triple filtered through a .45 micron filter. This removes oil residue.

Ref: MRT Laboratories

Microscopic Particle Analysis



Slide is visually examined using a bi-chromatic optical microscope.

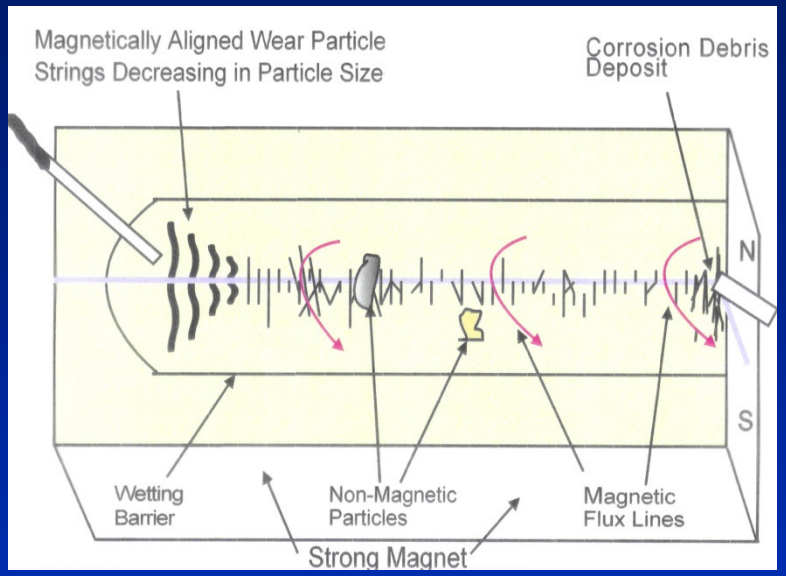
Lenses provide 100X, 500X, and 1000X views.

Color filters and polarizers help the analyst identify particles.

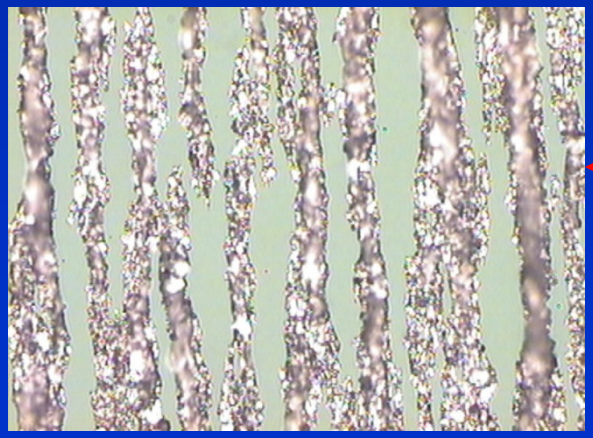
Heating the slide to transition temperatures will aid the analyst in identifying particles and determining broad metallurgy categories.

Ref: MRT Laboratories

Microscopic Particle Analysis



Analyst looks at magnetic alignment of particles to determine which are ferro-magnetic and which are other material.



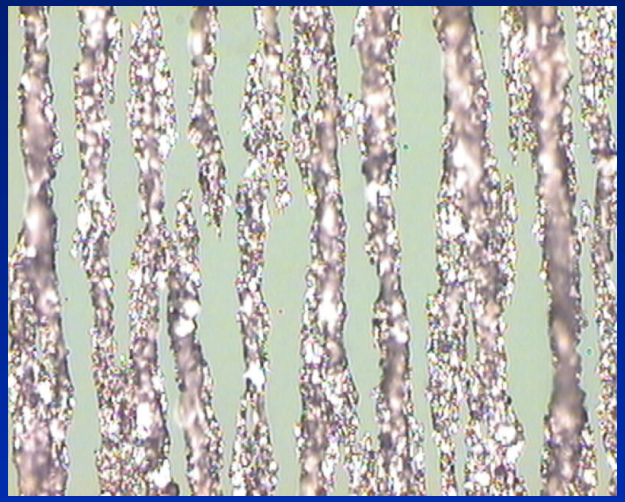
Metallic particles in magnetically aligned strings, indicating iron or steel.

Ref: MRT Laboratories

PARTICLE TYPES

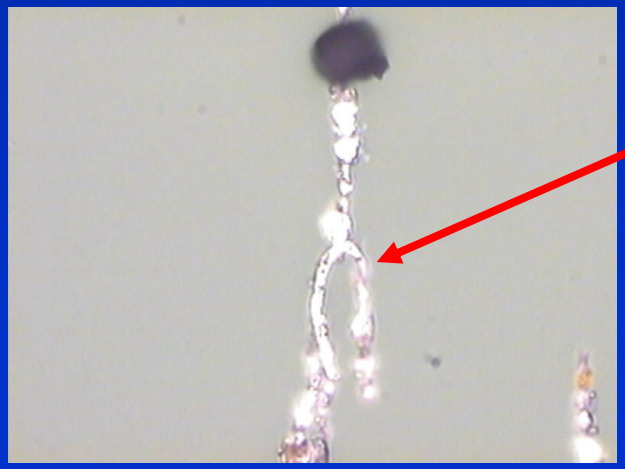
- Normal Rubbing Wear
- Severe Sliding Wear
- Cutting Wear
- Bearing & Gear Wear
- Spheres from Rolling Element Fatigue
- Black Oxides from Lubricant Starvation
- Babbitt Particles
- Corrosive Debris
- Lube Degradation
- Varnish & Lacquer Particles
- Sand & Dirt
- Fibers
- Contaminant Spheres
- Red Oxides from Water
- Red Oxides from Fretting Corrosion.

PARTICLE IDENTIFICATION



NORMAL RUBBING WEAR

Individual particles are generally 5 microns and below. The quantity of these particles determines the wear rate.

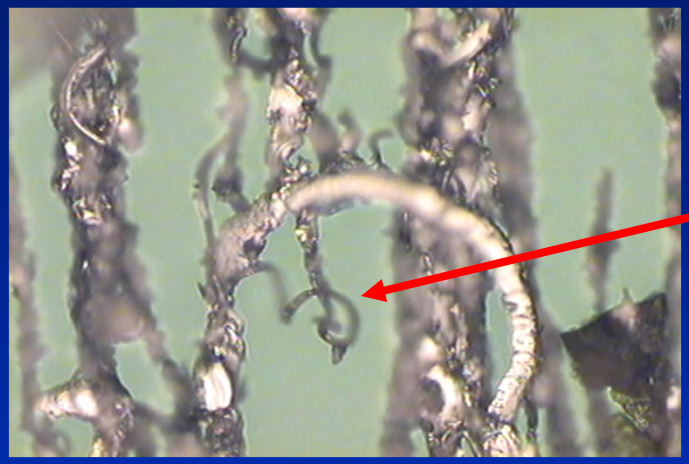


SMALL CUTTING WEAR

Small cutting wear particles such as this are usually caused by abrasion wear due to contaminants or other wear particles in the lubricant

Ref: MRT Laboratories

PARTICLE IDENTIFICATION



LARGE CUTTING WEAR

Large, curled cutting wear particles such as this are usually generated as a result of misalignment or abrasive particle embedded in a Babbitt bearing.

LARGE LAMINAR PARTICLES

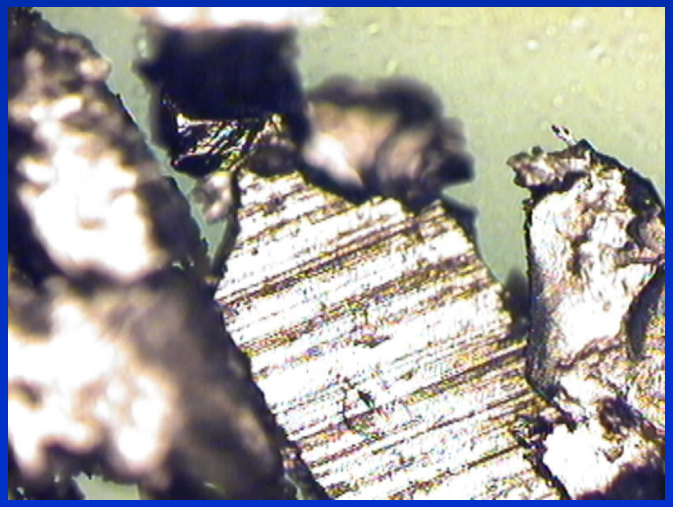
Large, rounded, flat particles with a width/thickness ration of 20-1 are generated as a result of rolling element fatigue. Macro-spalling is indicated if the particles are in the 40 micron size range.

Ref: MRT Laboratories

PARTICLE IDENTIFICATION

FATIGUE CRACK SPHERES

Fatigue cracks can generate small 1-10 micron spherical particles, sometimes copious amounts.



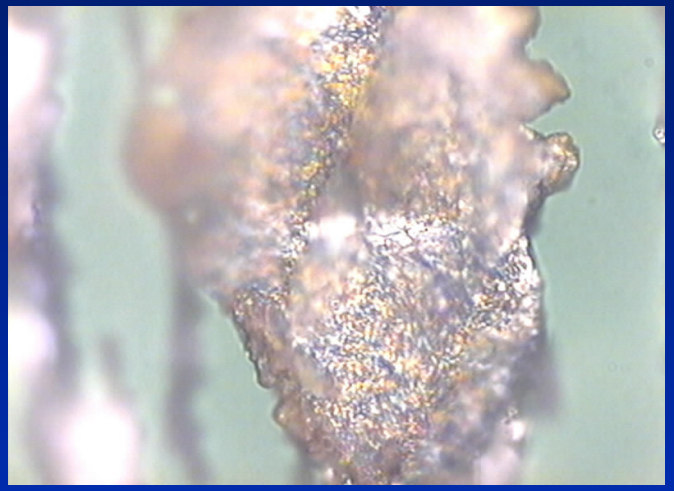
GEAR ROOT OR TIP WEAR

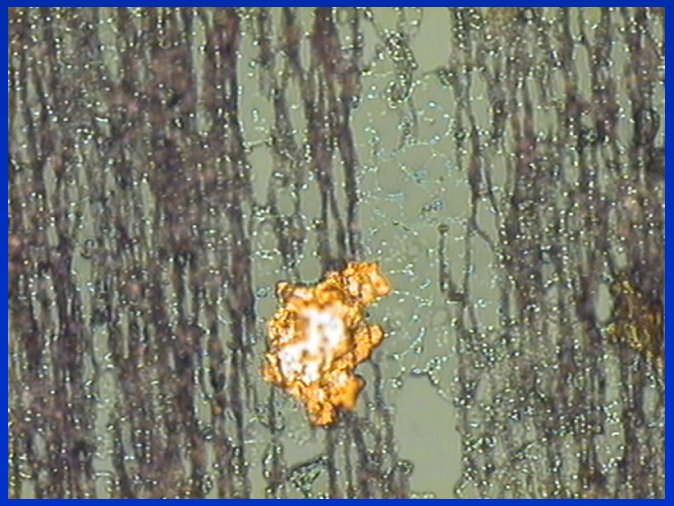
Severe Sliding Wear

Gear root or tip wear generates long, flat particles, often with striation marks as a result of the sliding that occurred during generation.

Ref: MRT Laboratories

PARTICLE IDENTIFICATION





BABBITT PARTICLES

Babbitt particles can be identified by their stippled, multicolored surfaces.

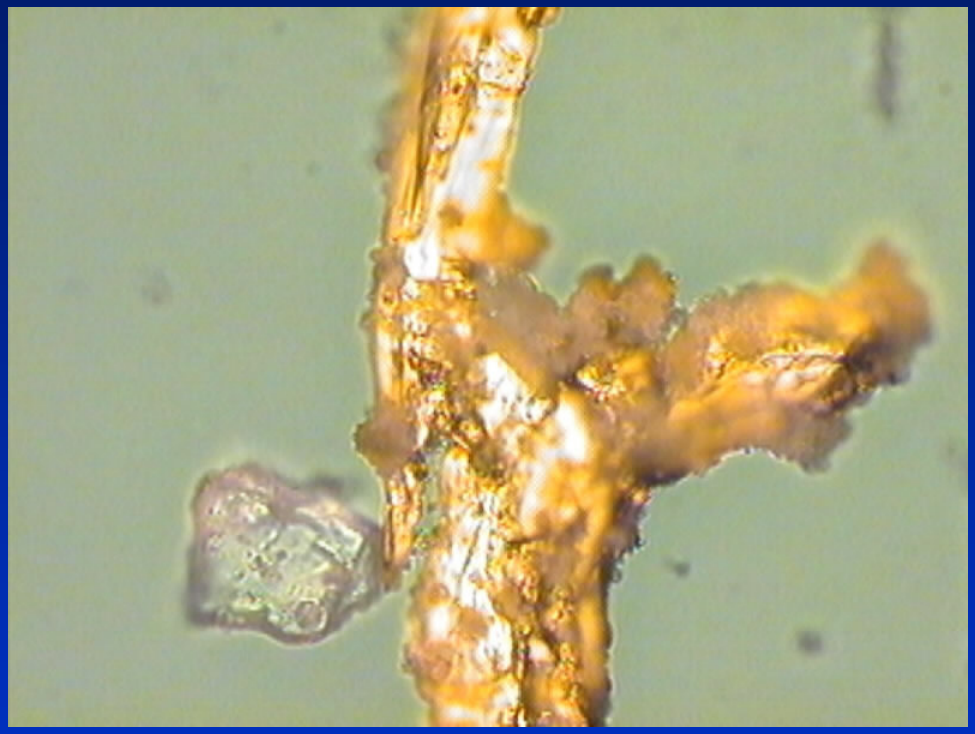
Their edges will often melt slightly when heated to 625° F

COPPER ALLOYS

Unheated, yellow metals are easily identified by their color. These are usually generated at roller bearing cages as a result of a lubrication problem.

Ref: MRT Laboratories

PARTICLE IDENTIFICATION

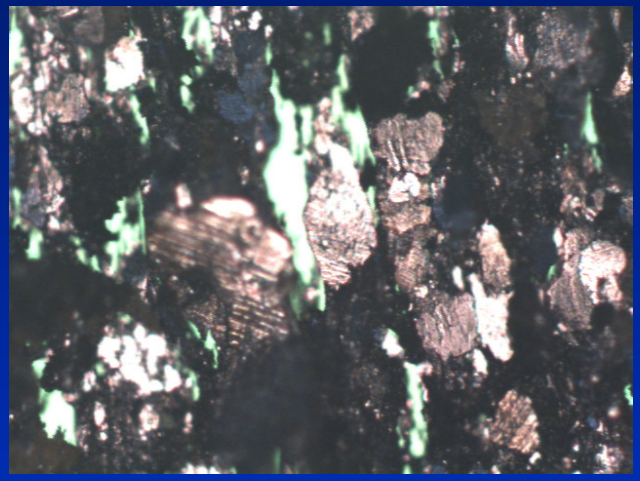


The tortuous shape of the particle will help determine the severity of wear.

Ref: MRT Laboratories

PARTICLE IDENTIFICATION

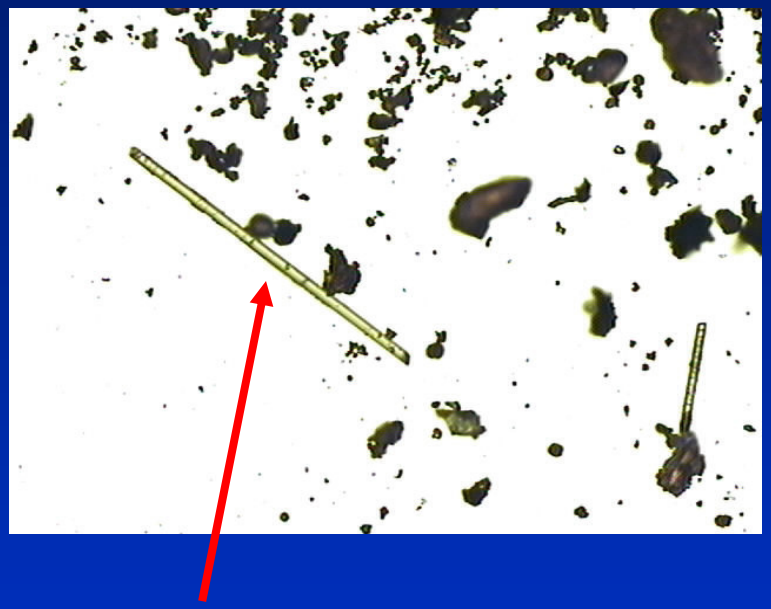
Corrosive Wear
Aged or Oxidized Lubricant



Black Oxides & Gear Wear
Lubricant Starvation

Ref: MRT Laboratories

PARTICLE IDENTIFICATION



Fiber Glass From Degraded Filter

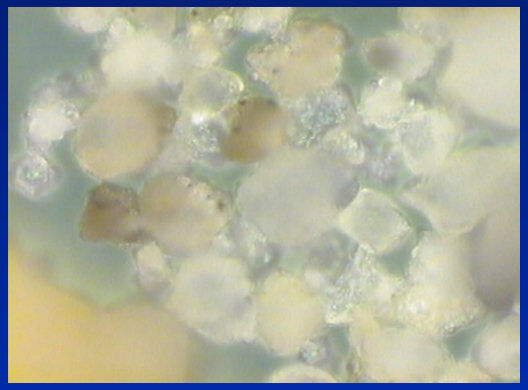
Large Red Iron Oxides from water contamination

Ref: MRT Laboratories

PARTICLE IDENTIFICATION

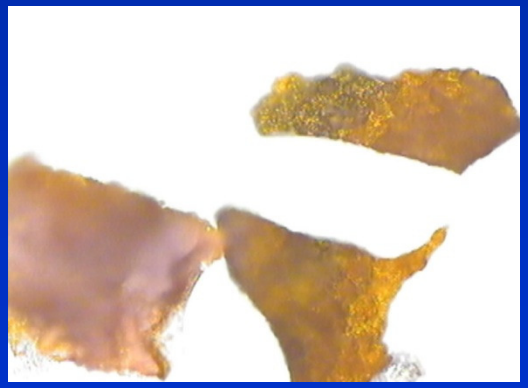
Contamination

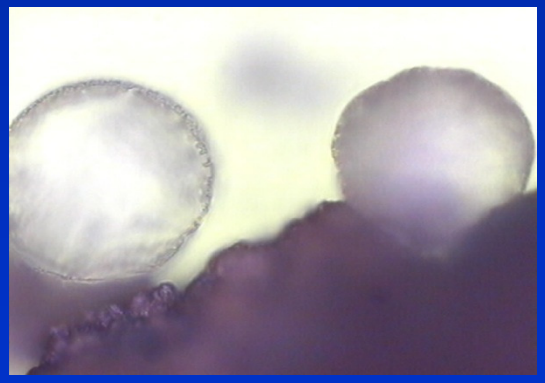
Airborne or Waterborne contaminants



Filter Degradation

Varnish and Lacquer Particles



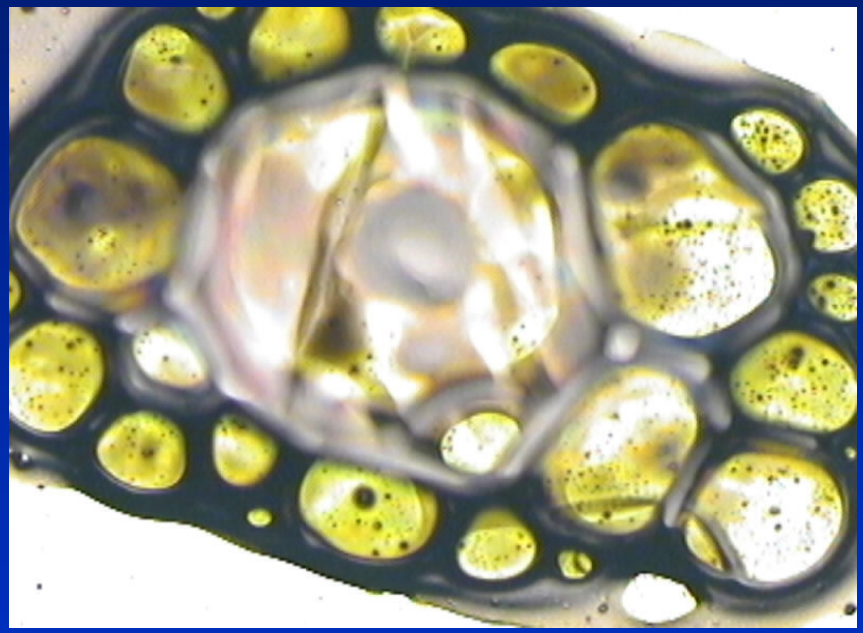


Product Contamination

Ref: MRT Laboratories

PARTICLE IDENTIFICATION

Contamination



We haven’t a clue

Ref: MRT Laboratories

PARTICLE IDENTIFICATION

Individual Particles can be examined usually at:

100X Magnification

At 100X, it can be determined this 500 micron particle is significant

500X Magnification

At 500X, details of the particle and its morphology become more evident.

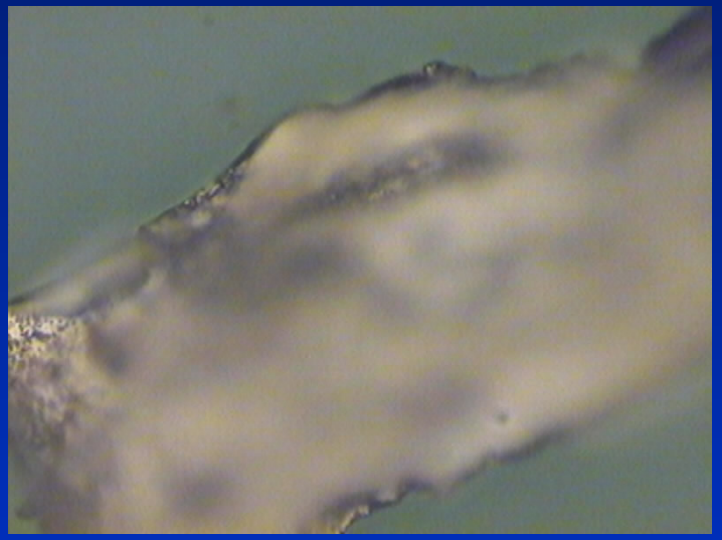
Ref: MRT Laboratories

PARTICLE IDENTIFICATION

1000X Magnification

At 1000X, minute details of the particle can be observed.

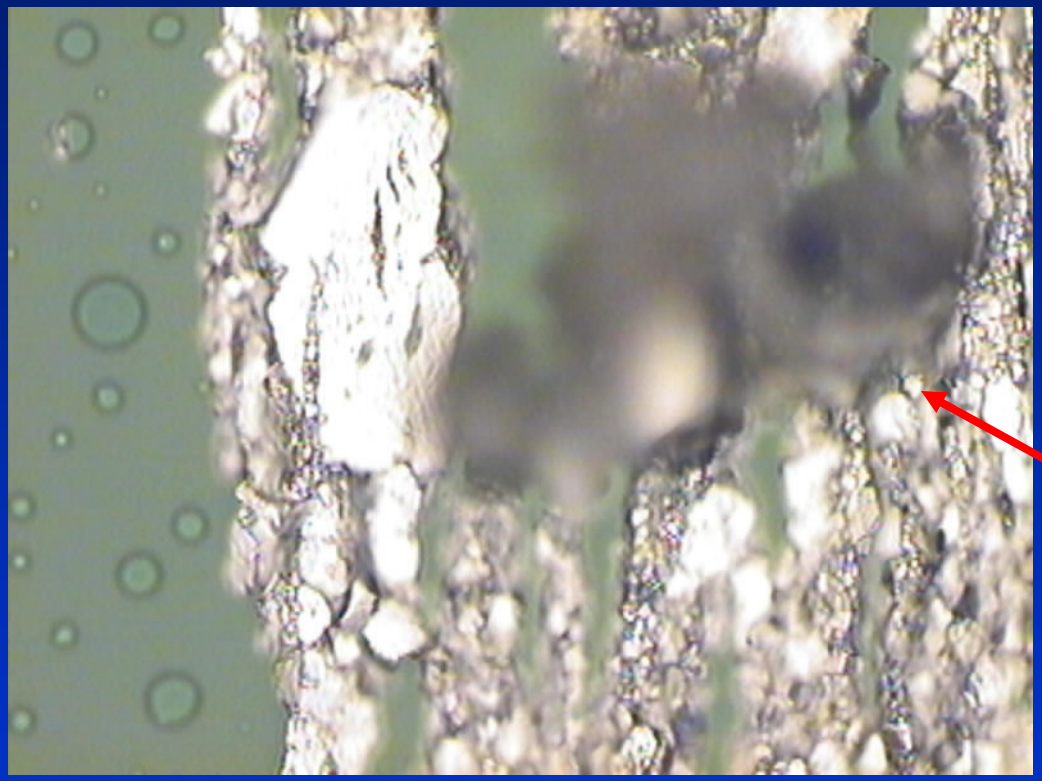
1000X Magnification



A measuring device on the microscope allows us to focus on the top and bottom of the particle and determine the ‘thickness’ in microns

Ref: MRT Laboratories

Microscopic Particle Analysis



At 1000X, particles as small as 1-2 microns can be observed and most often identified

2 micron ferrous wear particle.

Ref: MRT Laboratories

Temper Colors

Temper Colors

Determination of Metallurgy

TRANSITION TEMPERATURES

500F – Organic material will char, shrink and/or shrivel.

625F – Carbon Steel will turn blue

High Alloy steel will remain white

Cast iron and medium alloy steel will turn straw colored

Babbitt surface will oxidize and obtain a stippled, multi-colored appearance. Edges may melt slightly.

Aluminum and Chromium will remain white

Copper/brass/bronze will turn dark bronze with streaks of blue, red, and purple, depending on the alloy

Temper Colors

Determination of Metallurgy

TRANSITION TEMPERATURES – 750 Deg F.

Carbon steel	→	Light gray – light straw
Cast iron and medium alloy steel	→	Deep bronze
High alloy and Stainless Steel	→	No change or slight yellowing
Aluminum & Chromium	→	No change
Babbitt	→	Further stippled surface and some edge melting
Copper Alloys	→	Deep straw with red, purple, and blue coloring depending on the alloy
Organics	→	Further charring, shrinking, or vaporization

Temper Colors

Determination of Metallurgy

TRANSITION TEMPERATURES - 900 Deg F.

Carbon steel	→	Dark gray – dark straw
Cast iron and medium alloy steel	→	Deep bronze with mottled bluing
High nickel alloy steel	→	Bronze with significant bluing
Stainless Steel stainless	→	Light straw to bronze, some may have slight bluing
Aluminum & Chromium	→	No change
Babbitt	→	Surface completely oxidized dark. Edges melted.
Copper Alloys	→	Dark straw, may still have slight amount of reds, purples, and blue, depending on the alloy
Organics	→	Further charring, shrinking, or vaporization.

Temper Colors

Determination of Metallurgy

TRANSITION TEMPERATURES - 1000+ Deg F.

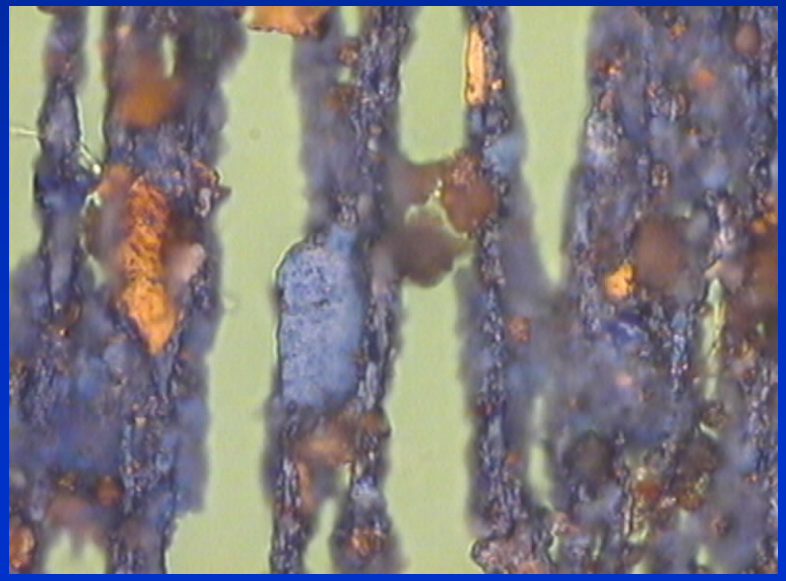
Carbon steel	→	Dark gray
Cast iron and medium alloy steel	→	Deep bronze with heavy bluing
High nickel alloy steel	→	Blue or blue/gray
Stainless Steel	→	Darker bronze with heavier mottled bluing
Aluminum & Chromium	→	No change
Babbitt	→	Surface completely oxidized dark. Edges definitely melted.
Copper Alloys	→	Dark straw, little reds, purples, and blue, depending on the alloy
Organics	→	Mostly melted into blobs or heavily deformed, or completely vaporized

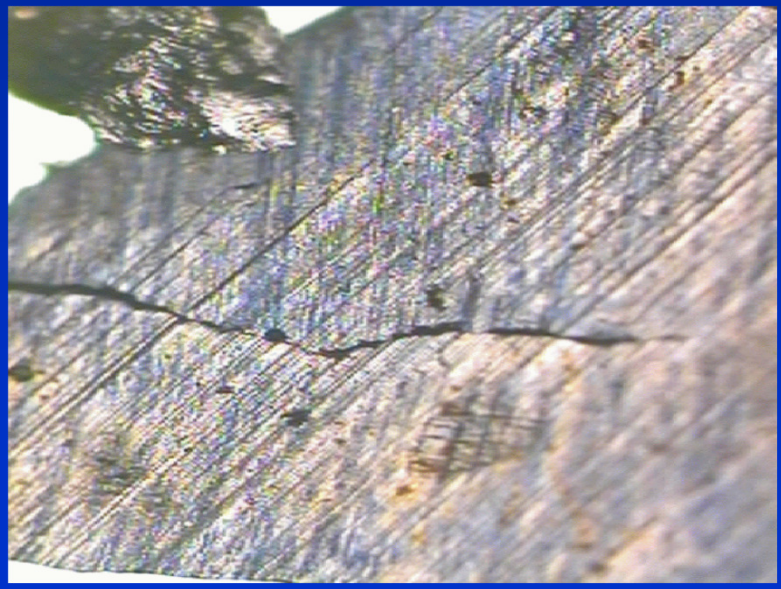
Temper Colors
Example: Determination of Metallurgy

Heated to 625F.

Those carbon steel particles <~100u will turn bluish when heated to 625F for 90 secs.

Much larger carbon steel particles will only turn slightly blue unless heated for a longer period of time.



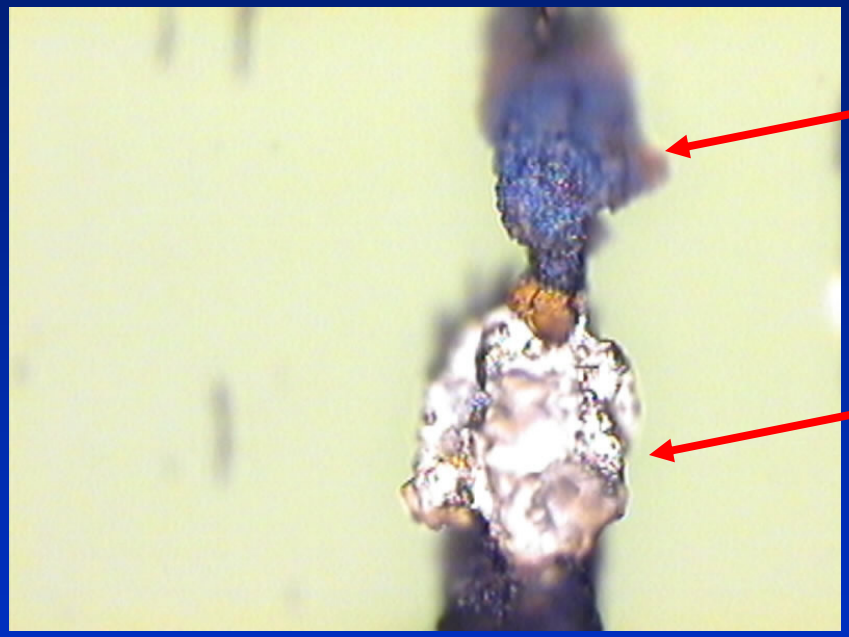


Ref: MRT Laboratories

Temper Colors

Example: Determination of Metallurgy

After heating slide to 625F



Carbon Steel

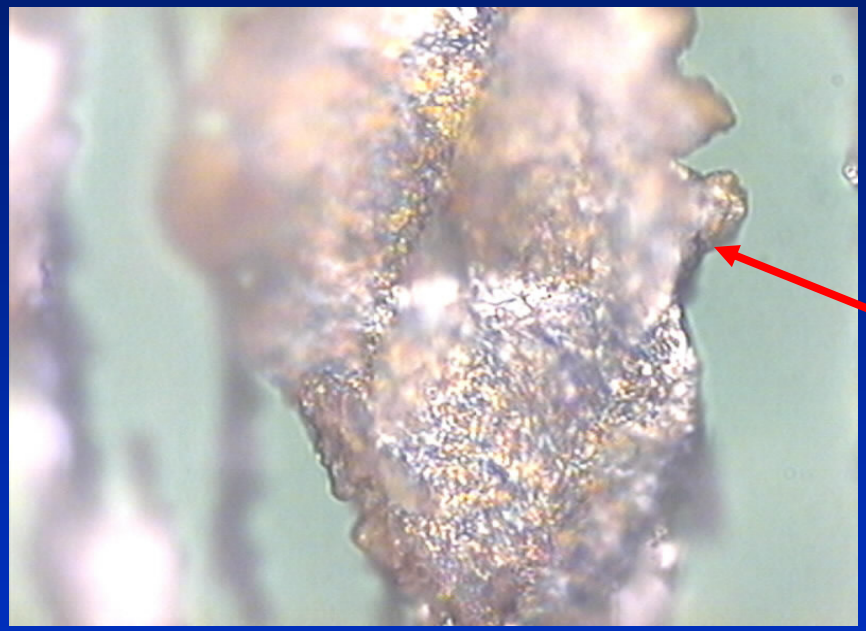
High Alloy Steel

If an excessive number of both these type of steel are present and the sample is from rolling element bearings, it probably indicates a loose fit.

Ref: MRT Laboratories

Temper Colors

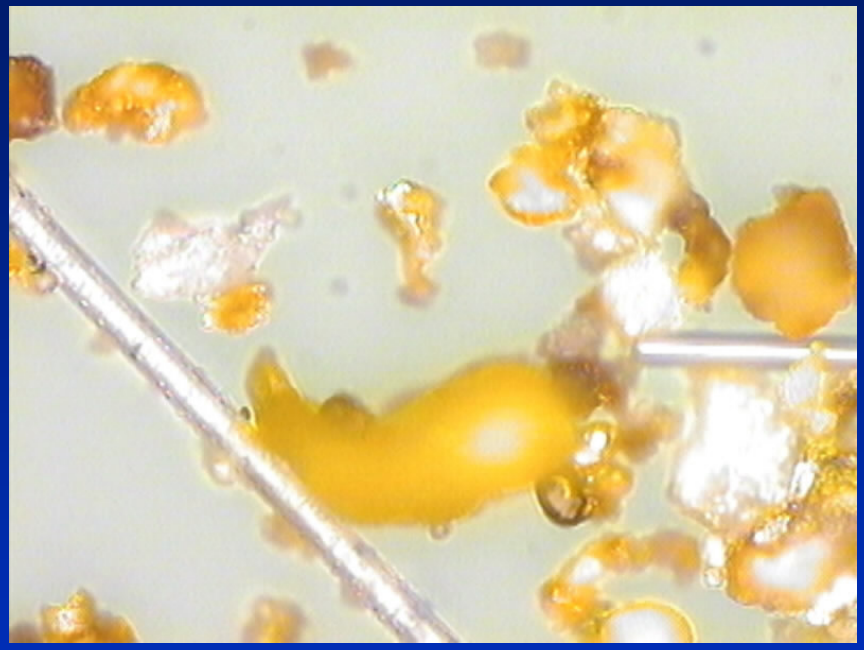
Example: Determination of Metallurgy



Babbitt will have a stippled appearance, along with often times melted edges when heated to 625F and above.

Ref: MRT Laboratories

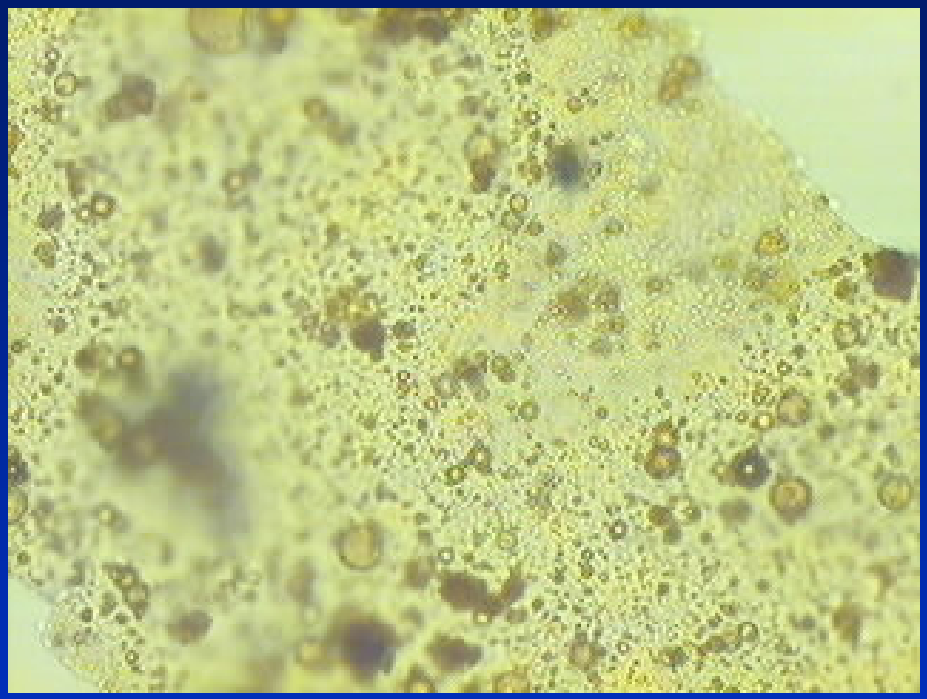
Other Determinations as a Result of Heating the Slide



Rust particles will turn bright reddish/orange as they are heated. Heating will have no effect on fiberglass debris from filters. This is one method of identifying fibrous material.

Ref: MRT Laboratories

Other Visible Indications



Friction polymers in a gear oil, indicating moderate to heavy lubricant stresses.

Ref: MRT Laboratories

Other Visible Indications

O-ring or Gasket Material

Ref: MRT Laboratories

Other Visible Indications

500X – heavy spalling from roller bearing element.

When heated to 625f for 120 seconds, these turned blue, indicating carbon steel.

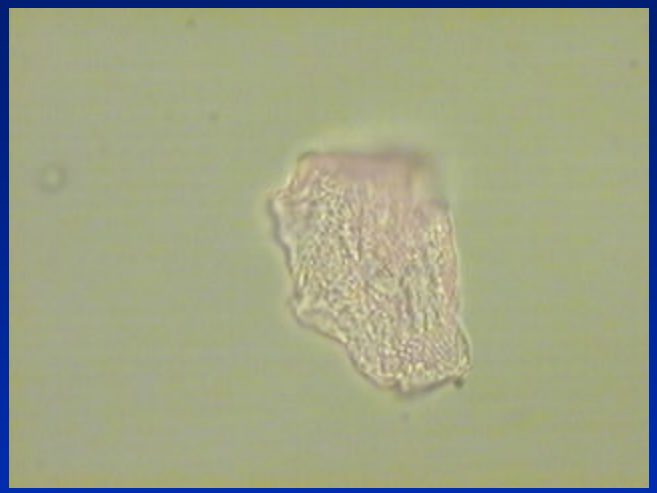
Ref: MRT Laboratories

Other Visible Indications

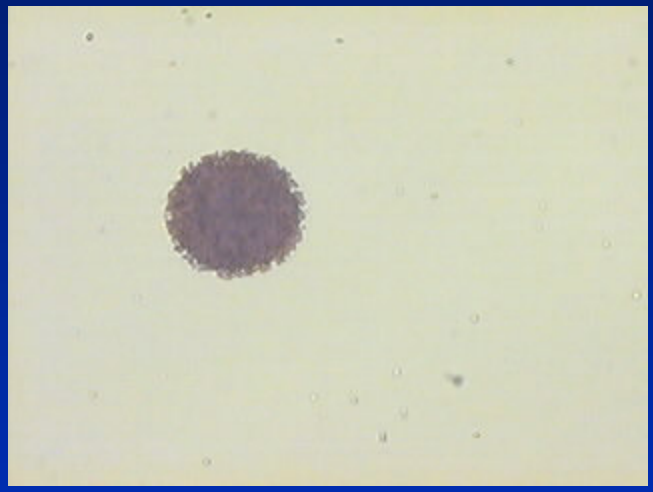
100X – Wear from a slinger ring.

Ref: MRT Laboratories

Other Visible Indications



Plastic Dust from filter or product.



After heating to 625 F, particle melts.

Ref: MRT Laboratories

Other Identifiable Particulates

- Catalyst Fines
- Sandblasting Sand
- Molybdenum Disulfide Additives
- Graphite Additives
- Teflon Tape particles
- Wax Globules
- Bio- Mass
- Insect Parts

Microscopic Particle Analysis

Additional Points !!

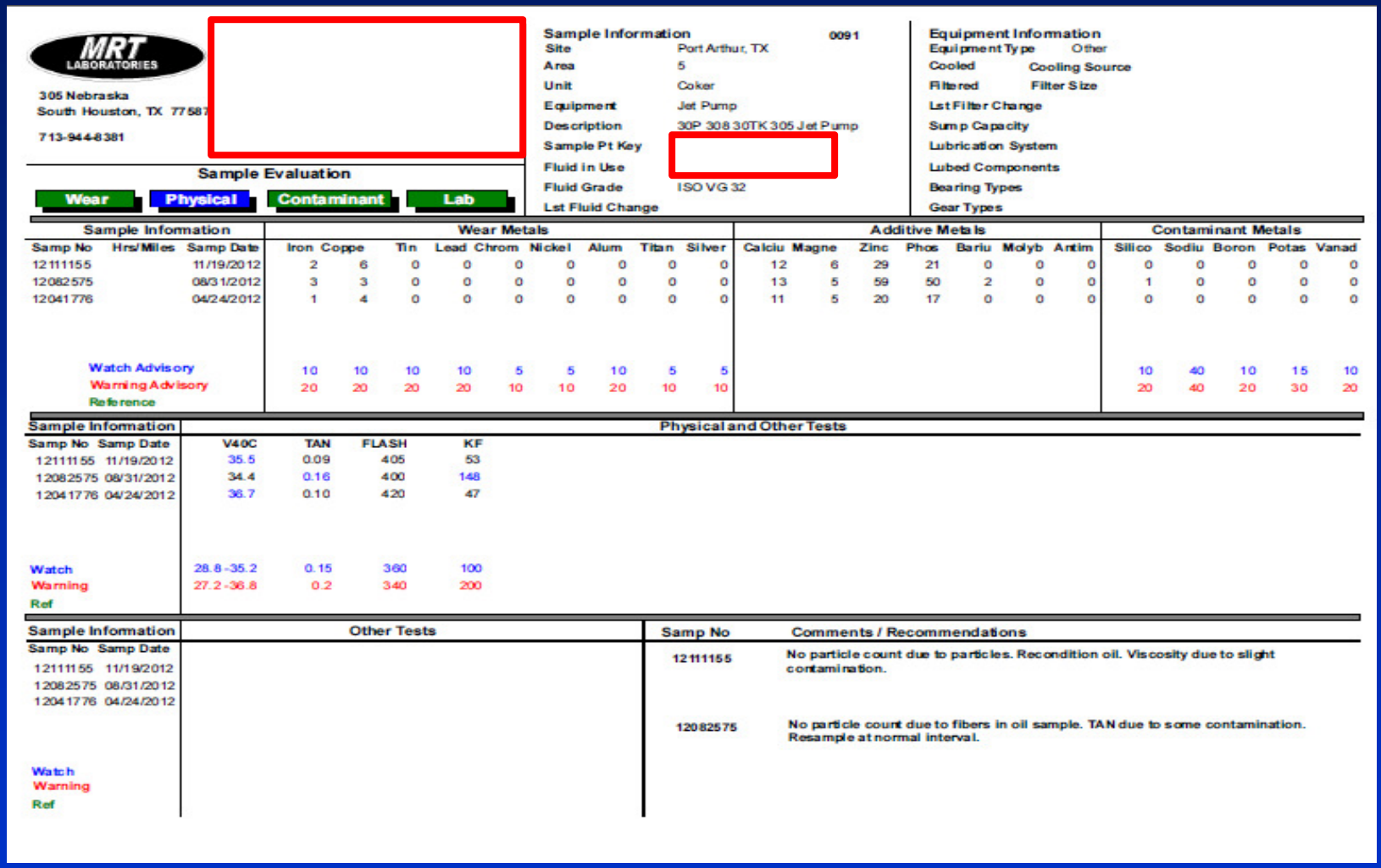
Often what is NOT observed is as important as what is observed

When used in conjunction with routine Lube Oil Analysis, Analytical Ferrography will enhance the effectiveness of your Analysis Program

The more experienced the ferrographer, the better the results, and the more familiar the ferrographer is with the equipment in question, the better the results.

Share information with your lab. When a piece of equipment is opened for inspection, let your lab know what you found compared to the analysis report.

Examples Of Ferrography Detecting a Problem



MRT LABORATORIES

305 Nebraska
South Houston, TX 77587

713-944-8381

Sample Evaluation

Wear | Physical | Contaminant | Lab

Sample Information 0091
Site Port Arthur, TX
Area 5
Unit Coker
Equipment Jet Pump
Description 30P 308 30TK 305 Jet Pump
Sample Pt Key
Fluid in Use
Fluid Grade ISO VG 32
Lst Fluid Change

Equipment Information
Equipment Type Other
Cooled Cooling Source
Filtered Filter Size
Lst Filter Change
Sump Capacity
Lubrication System
Lubed Components
Bearing Types
Gear Types

Sample Information			Wear Metals									Additive Metals							Contaminant Metals					
Samp No	Hrs/Miles	Samp Date	Iron	Coppe	Tin	Lead	Chrom	Nickel	Alum	Titan	Silver	Calciu	Magne	Zinc	Phos	Bariu	Molyb	Antim	Silico	Sodiu	Boron	Potas	Vanad
12111155		11/19/2012	2	6	0	0	0	0	0	0	0	12	6	29	21	0	0	0	0	0	0	0	0
12082575		08/31/2012	3	3	0	0	0	0	0	0	0	13	5	59	50	2	0	0	1	0	0	0	0
12041776		04/24/2012	1	4	0	0	0	0	0	0	0	11	5	20	17	0	0	0	0	0	0	0	0
Watch Advisory			10	10	10	10	5	5	10	5	5								10	40	10	15	10
Warning Advisory			20	20	20	20	10	10	20	10	10								20	40	20	30	20
Reference																							

Sample Information		Physical and Other Tests			
Samp No	Samp Date	V40C	TAN	FLASH	KF
12111155	11/19/2012	35.5	0.09	405	53
12082575	08/31/2012	34.4	0.16	400	148
12041776	04/24/2012	36.7	0.10	420	47
Watch		28.8 - 35.2	0.15	360	100
Warning		27.2 - 36.8	0.2	340	200
Ref					

Sample Information		Other Tests
Samp No	Samp Date	
12111155	11/19/2012	
12082575	08/31/2012	
12041776	04/24/2012	
Watch		
Warning		
Ref		

Samp No	Comments / Recommendations
12111155	No particle count due to particles. Recondition oil. Viscosity due to slight contamination.
12082575	No particle count due to fibers in oil sample. TAN due to some contamination. Resample at normal interval.

Nothing alarming in standard report, but…..

Examples Of Ferrography Detecting a Problem

MRT LABORATORIES

305 Nebraska
South Houston, TX 77587
713-944-8381

Sample Point Information 0091

Site	Port Arthur, TX
Area	5
Unit	Coker
Equipment	Jet Pump
Description	30P 308 30TK 305 Jet Pump
Sample Pt Key	

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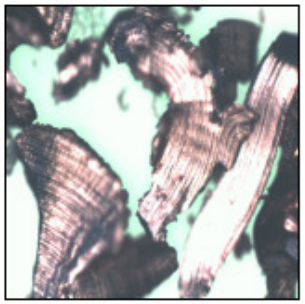
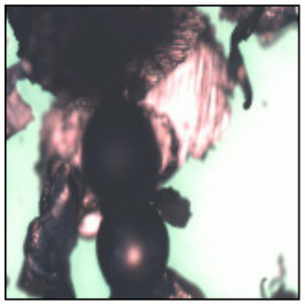
Sample Information

Sample Number	12111155
Sample Date	11/19/2012
Report Date	11/20/2012



12111155a.jpg 100 X

These 200 to 500 micron ferrous cutting wear particles are typical of the others on the slide. These are abrasive wear. Check unit for noise or vibration. Recondition oil.

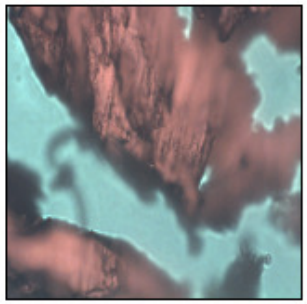


12111155b.jpg 100 X

These two 160 micron metal spheres are the largest of the few seen. These are from bearing fatigue cracks.

12111155c.jpg 500 X

This 40 micron copper particle is one of 2 seen. The other particle is filter material.



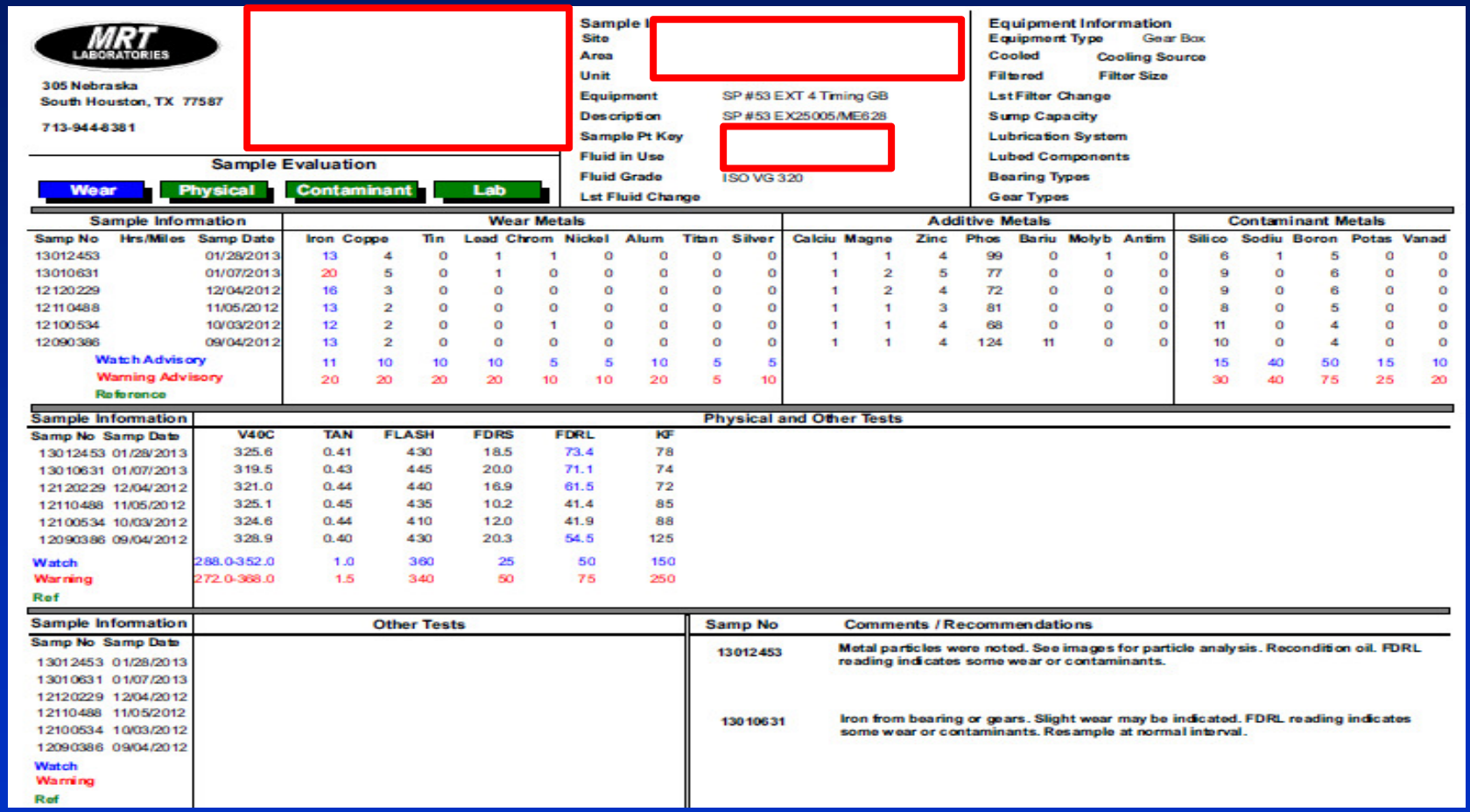
12111155d.jp 500 X

This is after heating the slide to 625F. Most of the ferrous particles turned bronze. They are medium alloy steel. A few turned blue, carbon steel. Most of these appear to be from the bearing.

Several large ferrous cutting wear particles (abrasive wear) were seen. Most of these appear to be from the bearing. Check for noise or vibration. Recondition oil. A few large metal spheres that appear to be from bearing fatigue cracks were also seen.

Severe wear was detected with ferrography

Examples Of Ferrography Detecting a Problem



MRT LABORATORIES

305 Nebraska
South Houston, TX 77587
713-944-8381

Sample Evaluation: Wear | Physical | Contaminant | Lab

Sample I
Site
Area
Unit
Equipment: SP #53 EXT 4 Timing GB
Description: SP #53 EX25005/ME628
Sample Pt Key
Fluid in Use
Fluid Grade: ISO VG 320
Lst Fluid Change

Equipment Information
Equipment Type: Gear Box
Cooled | Cooling Source
Filtered | Filter Size
Lst Filter Change
Sump Capacity
Lubrication System
Lubed Components
Bearing Types
Gear Types

Sample Information			Wear Metals									Additive Metals								Contaminant Metals					
Samp No	Hrs/Miles	Samp Date	Iron	Coppe	Tin	Lead	Chrom	Nickel	Alum	Titan	Silver	Calciu	Magne	Zinc	Phos	Bariu	Molyb	Antim		Silico	Sodiu	Boron	Potas	Vanad	
13012453		01/28/2013	13	4	0	1	1	0	0	0	0	1	1	4	99	0	1	0		6	1	5	0	0	
13010631		01/07/2013	20	5	0	1	0	0	0	0	0	1	2	5	77	0	0	0		9	0	6	0	0	
12120229		12/04/2012	16	3	0	0	0	0	0	0	0	1	2	4	72	0	0	0		9	0	6	0	0	
12110488		11/05/2012	13	2	0	0	0	0	0	0	0	1	1	3	81	0	0	0		8	0	5	0	0	
12100534		10/03/2012	12	2	0	0	1	0	0	0	0	1	1	4	68	0	0	0		11	0	4	0	0	
12090386		09/04/2012	13	2	0	0	0	0	0	0	0	1	1	4	124	11	0	0		10	0	4	0	0	
	Watch Advisory		11	10	10	10	5	5	10	5	5									15	40	50	15	10	
	Warning Advisory		20	20	20	20	10	10	20	5	10									30	40	75	25	20	
	Reference																								

Sample Information		Physical and Other Tests					
Samp No	Samp Date	V40C	TAN	FLASH	FDRS	FDRL	KF
13012453	01/28/2013	325.6	0.41	430	18.5	73.4	78
13010631	01/07/2013	319.5	0.43	445	20.0	71.1	74
12120229	12/04/2012	321.0	0.44	440	16.9	61.5	72
12110488	11/05/2012	325.1	0.45	435	10.2	41.4	85
12100534	10/03/2012	324.6	0.44	410	12.0	41.9	88
12090386	09/04/2012	328.9	0.40	430	20.3	54.5	125
Watch		288.0-352.0	1.0	360	25	50	150
Warning		272.0-368.0	1.5	340	50	75	250
Ref							

Sample Information		Other Tests
Samp No	Samp Date	
13012453	01/28/2013	
13010631	01/07/2013	
12120229	12/04/2012	
12110488	11/05/2012	
12100534	10/03/2012	
12090386	09/04/2012	
Watch		
Warning		
Ref		

Samp No	Comments / Recommendations
13012453	Metal particles were noted. See images for particle analysis. Recondition oil. FDRL reading indicates some wear or contaminants.
13010631	Iron from bearing or gears. Slight wear may be indicated. FDRL reading indicates some wear or contaminants. Resample at normal interval.

Steady iron increase, then drop while FDRL increases

Examples Of Ferrography Detecting a Problem

MRT LABORATORIES

305 Nebraska
South Houston, TX 77587
713-944-8381

[redacted]

Sample Point Information 0053

[redacted]

Unit Extruders
Equipment SP #53 EXT 4 Timing GB
Description
Sample Pt Key [redacted]

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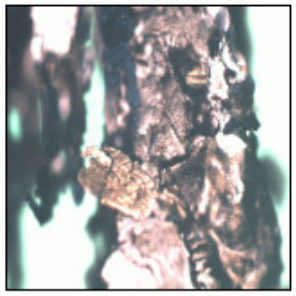
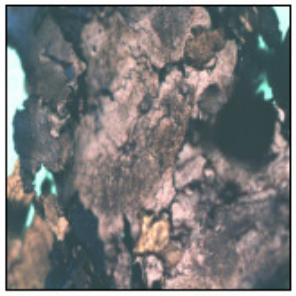
Sample Information
Sample Number 13012453
Sample Date 01/28/2013
Report Date 02/01/2013



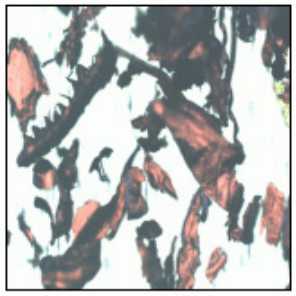
13012453a.jpg 100 X

Many large 100 to 900 micron ferrous wear particles and copper particles were seen. Check bearing for severe wear/damage. A few of these appear to be from the gears.



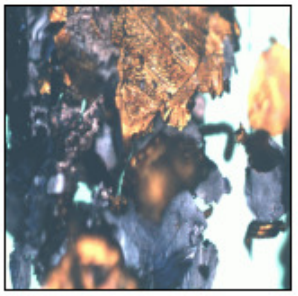
13012453b.jpg 100 X

These large ferrous particles are 500 to 900 microns. They appear to be from a bearing. A few copper particle can be seen.



13012453c.jpg 100 X

These particles are almost all copper particles. Some are copper cutting wear particles. Inspect bearing cage for severe damage.



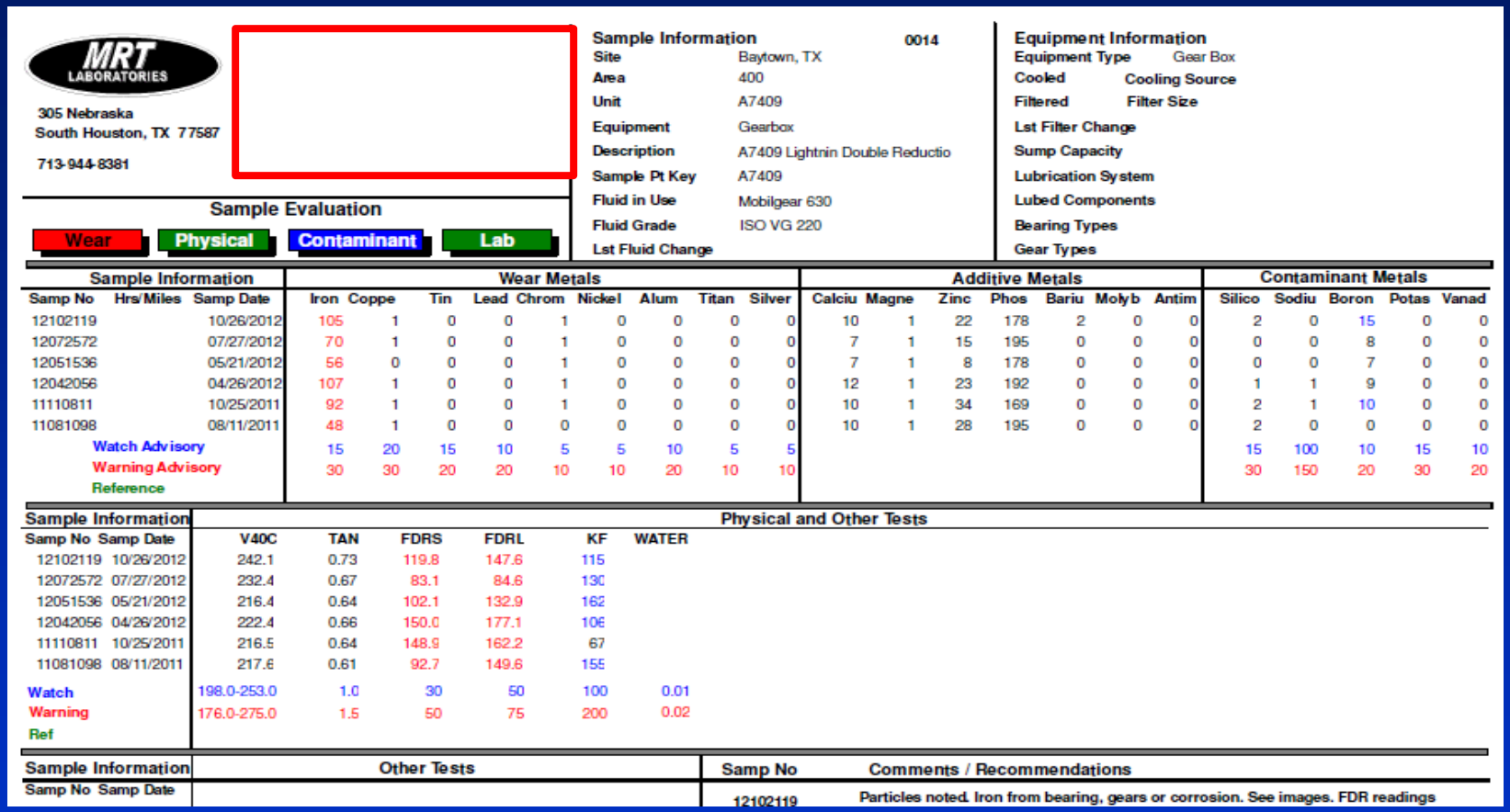
13012453d.jp 100 X

This is after heating the slide to 625F. Most of the ferrous particles turned blue, carbon steel. Copper particles are seen.

Large numbers of copper particles 50 to 500 micron were seen over the slide. Check bearing cage for severe wear. Many large ferrous wear particles were also seen. Check for increased noise or vibration or inspect bearing and if possible the gears. Severe wear is indicated.

This is what an extruder gearbox looks like to us when it is starting to fall apart!

Examples Of Ferrography Detecting a Problem



MRT LABORATORIES

305 Nebraska
South Houston, TX 77587

713-944-8381

Sample Evaluation

Wear | Physical | Contaminant | Lab

Sample Information 0014

Site	Baytown, TX
Area	400
Unit	A7409
Equipment	Gearbox
Description	A7409 Lightnin Double Reductio
Sample Pt Key	A7409
Fluid in Use	Mobilgear 630
Fluid Grade	ISO VG 220
Lst Fluid Change	

Equipment Information

Equipment Type	Gear Box
Cooled	Cooling Source
Filtered	Filter Size
Lst Filter Change	
Sump Capacity	
Lubrication System	
Lubed Components	
Bearing Types	
Gear Types	

Sample Information			Wear Metals									Additive Metals							Contaminant Metals				
Samp No	Hrs/Miles	Samp Date	Iron	Coppe	Tin	Lead	Chrom	Nickel	Alum	Titan	Silver	Calciu	Magne	Zinc	Phos	Bariu	Molyb	Antim	Silico	Sodiu	Boron	Potas	Vanad
12102119		10/26/2012	105	1	0	0	1	0	0	0	0	10	1	22	178	2	0	0	2	0	15	0	0
12072572		07/27/2012	70	1	0	0	1	0	0	0	0	7	1	15	195	0	0	0	0	0	8	0	0
12051536		05/21/2012	56	0	0	0	1	0	0	0	0	7	1	8	178	0	0	0	0	0	7	0	0
12042056		04/26/2012	107	1	0	0	1	0	0	0	0	12	1	23	192	0	0	0	1	1	9	0	0
11110811		10/25/2011	92	1	0	0	1	0	0	0	0	10	1	34	169	0	0	0	2	1	10	0	0
11081098		08/11/2011	48	1	0	0	0	0	0	0	0	10	1	28	195	0	0	0	2	0	0	0	0
Watch Advisory			15	20	15	10	5	5	10	5	5								15	100	10	15	10
Warning Advisory			30	30	20	20	10	10	20	10	10								30	150	20	30	20
Reference																							

Sample Information		Physical and Other Tests					
Samp No	Samp Date	V40C	TAN	FDRS	FDRL	KF	WATER
12102119	10/26/2012	242.1	0.73	119.8	147.6	115	
12072572	07/27/2012	232.4	0.67	83.1	84.6	130	
12051536	05/21/2012	216.4	0.64	102.1	132.9	162	
12042056	04/26/2012	222.4	0.66	150.0	177.1	106	
11110811	10/25/2011	216.5	0.64	148.9	162.2	67	
11081098	08/11/2011	217.6	0.61	92.7	149.6	155	
Watch		198.0-253.0	1.0	30	50	100	0.01
Warning		176.0-275.0	1.5	50	75	200	0.02
Ref							

Sample Information		Other Tests
Samp No	Samp Date	

Samp No	Comments / Recommendations
12102119	Particles noted. Iron from bearing, gears or corrosion. See images. FDR readings

Just changing the oil doesn't always solve a wear problem.

Examples Of Ferrography Detecting a Problem

MRT LABORATORIES

305 Nebraska
South Houston, TX 77587
713-944-8381

Sample Point Information 0014

Site	Baytown, TX
Area	400
Unit	A7409
Equipment	Gearbox
Description	A7409 Lightnin Double Reductio
Sample Pt Key	A7409

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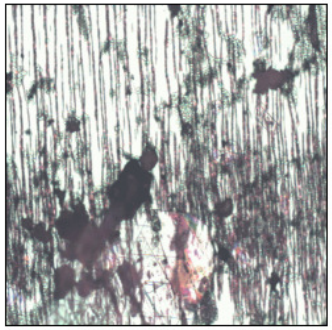
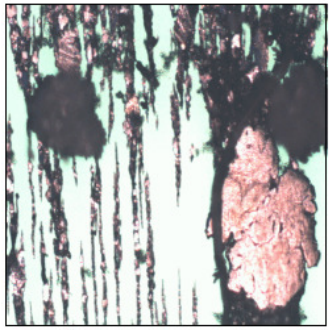
Sample Information

Sample Number	12102119
Sample Date	10/26/2012
Report Date	10/31/2012



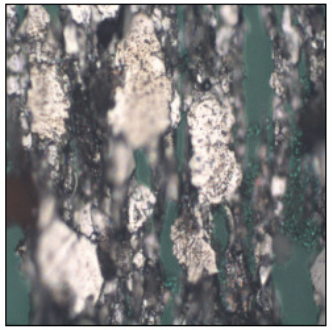
12102119a.jpg 100 X

Many fibers were seen. Some type of clear non-metallic material was also seen (clear particle at bottom). This particle melted when heated. It could be product. Many ferrous corrosion particles were seen.



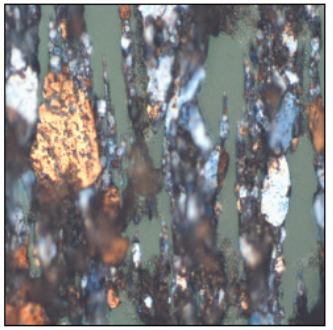
12102119b.jpg 100 X

This 300 micron ferrous wear particle appears to be from a bearing. It was the largest seen. Most of the many wear particles were 30 microns or less. Many were 30 to 80 microns. Check for noise or vibration. Some severe wear may be indicated.



12102119c.jpg 500 X

These are typical of the ferrous wear particles. Most appear to be gear wear. A few ferrous cutting wear particles are also seen. Recondition oil.



12102119d.jp 500 X

This is after heating the slide to 625F. Many of the ferrous particles tunred blue. They are carbon steel. The bronze color particles are medium alloy steel.

If the wear mode is other than contaminated lubricant the wear process will continue even after changing the oil

QUESTIONS ?

Thank You !!